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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

John L. Klocke and Linlin Chen

Application No. 10/688,420

Filed: October 16, 2003

Confirmation No. 2239

For: ELECTROPLATING COMPOSITIONS
AND METHODS FOR
ELECTROPLATING

Examiner: Edna Wong

Art Unit: 1753


Attorney Reference No. 6884-65576-01

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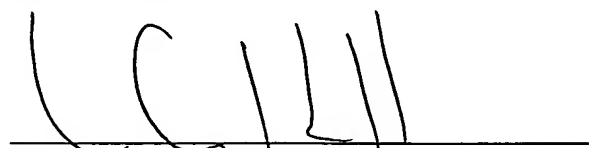
Enclosed for filing in the application referenced above are the following:

- ☒ Response to Non-Compliant Appeal Brief
- ☒ The Director is hereby authorized to charge any additional fees that may be required, or credit over-payment, to Deposit Account No. 02-4550. A copy of this sheet is enclosed.
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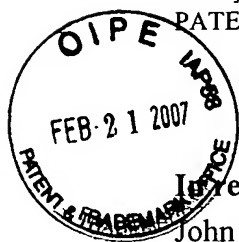
Respectfully submitted,

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RESPONSE TO NON-COMPLIANT APPEAL BRIEF

This is in response to the Notification of Non-Compliant Appeal Brief mail date January 18, 2007.

On January 22, 2007, Applicants' counsel spoke to Patent Appeal Center Specialist Bridget Monroe in regard to the subject Notification. Counsel and Ms. Monroe discussed how the Summary previously provided in the Brief met the rules as set forth in the CFR and Ms. Monroe said that a statement to this affect was sufficient to respond to the Notification of Non-Compliant Appeal Brief. Nonetheless, to aid the Board in its review of the present patent application claims and the pending rejections of the same, Applicant has added claim references to the Summary where certain claimed features of the invention as set forth in the independent claims, are mentioned in the Summary. It should be noted that although the Summary includes citations to particular page and line numbers of the specification where features of the cited claims are discussed, those may not be the only place within the specification such features are discussed.

SUPPLEMENTAL SUMMARY OF THE CLAIMED SUBJECT MATTER

In the production of semiconductor integrated circuits, metal layers on a workpiece (such as wafers) are deposited to serve as interconnect metallization that electrically connects various devices on the integrated circuit to one another (p. 1, ll. 10-14).¹ Electrodeposition may be used to deposit the metal layers (p. 2, ll. 17-21).

Electroplating compositions often comprise copper (e.g., copper sulfate) and an acid (e.g., sulfuric acid) (p. 2, ll. 26-27). The acid provides the high ionic conductivity to the plating composition necessary to achieve high throwing power. "Throwing power" refers to the ability of an electroplating composition to deposit metal uniformly on a wafer substrate (p. 2, l. 27 – p. 3, l. 3). If the composition has a low concentration of copper and a high concentration of acid, throwing power of the composition is improved (p. 3, ll. 3-7).

Conventional plating solutions comprise either relatively high acid concentration to low copper concentration ratios *or* low acid concentration to high copper concentration ratios (p. 3, l. 7 – p. 4, l. 25; p. 8, ll. 24-28). There is poor metal filling capability when using a plating composition superior in throwing power and coating uniformity (i.e., high acid to low copper compositions) to fill copper into high aspect ratio features (p. 4, ll. 1-8; p. 8, ll. 24-28). High aspect ratio features refer to the ratio of the depth to width of the interconnect features, e.g., trenches or contact holes (p. 4, ll. 1-8; p. 8, ll. 24-28). But using a conventional low acid, high copper plating composition provides inferior throwing power and suppressed additive activity, resulting in unplated areas within features (p. 4, ll. 8-10; p. 8, ll. 24-28).

Attempts to address the problems introduced using the conventional plating compositions (i.e., compositions having a high acid concentration to low copper concentration of or visa versa) are not satisfactory. Such attempts include the inclusion of additives such as suppressors, accelerators, and/or levelers (p. 4, ll. 23-28).

¹ Please note: Although citations to page and line numbers of the application are provided for support of the summary text herein, those may not be the only place within the specification such items are discussed and are not chosen to carry more or less interpretive weight than other, not cited, mentions in the specification.

Applicants, contrary to conventional wisdom, developed compositions including copper and acid at previously avoided relative concentrations. Applicants' compositions have relatively low acid concentrations to relatively low copper concentrations as compared to the prior art (p. 9, ll. 1-3). Put another way, Applicants' compositions have relatively low and narrow acid to copper concentration ratios.

Using comparative testing, Applicants confirmed that their invention provided depositions far exceeding the prior art compositions. Comparative tests are shown in the specification on page 22, line 1 through page 27, line 4. For comparison testing, the prior art electroplating compositions (which notably are almost identical in composition to the art cited in the Office actions against the present claims as discussed below) were tested under the same conditions with identical additives at the identical additives concentrations. The only parameter varied between the currently claimed compositions and the prior art compositions were the relative concentrations of acid to copper (p. 22, ll. 16-17). The test results reported for the compositions claimed having relatively low acid to copper concentration ratios (unlike the high ratios of the prior art) indicate the unexpected superior results of the currently disclosed compositions (p. 22, l. 22 – p. 23, l. 6; p. 23, ll. 7-14; p. 24, l. 4 – p. 25, l. 2 – for ease of reference, these pages are attached hereto as XII Appendix – Comparative Tests as Disclosed in the Specification).

Claimed embodiments of Applicants' electroplating compositions comprise:

an aqueous mixture of copper and sulfuric acid wherein the ratio of copper concentration to sulfuric acid concentration is from about 0.3 to about 0.8
(p. 9; ll. 4-13; claims 26, 34, and 68)

or

wherein the compositions have certain, relatively narrow acid and copper concentration ranges, for example, about 65 to about 150 g/L acid and about 35 to 60 g/L copper (i.e., a 1.1 to 4.3 acid to copper ratio)
(p. 9, ll. 21-26; claims 1, 6, 15, 19, 44, 53, 55, 63, and 66)

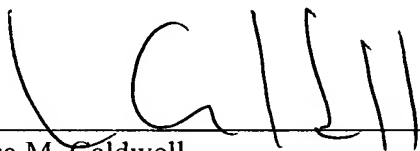
and other narrower ratio ranges. Certain of Applicants' claimed compositions also comprise:
an aqueous mixture of copper and sulfuric acid wherein the copper
concentration is within about 60% to about 90% of its solubility limit
when the sulfuric acid concentration is from about 65 to about 150 g/L
(p. 9; ll. 14-21; claim 35).

Other compositions of even narrower ranges and relative concentrations of acid to copper
are also disclosed (p. 9, l. 8 – p. 10, l. 4; claims 19, 26, 44, and 53) and claimed in certain
independent claims. These compositions may also include conventional additives, such as
accelerators, suppressors, halides and/or levelers (p. 10, ll. 11-18; p. 11, ll. 4-5; p. 11, ll. 21-22;
p. 12, ll. 23-26).

Respectfully submitted,

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